

## CLAIMS

What is claimed is:

1. A method for providing speech therapy comprising:

- 5 (A) displaying a model representation of a position of contact between a model tongue and mouth during speech; and  
(B) displaying a representation of a position of contact between a learner's tongue and mouth during speech.

10 2. The method of claim 1 further comprising (C) instructing the learner to mimic the model representation of the position of contact between the model tongue and mouth during speech.

15 3. The method of claim 2 further comprising the step of comparing the representation of the position of contact between the learner's tongue and mouth during speech with the model representation of position of contact between the model tongue and mouth during speech.

20 4. The method of claim 2 further comprising the step of generating a numerical score representing the closeness of fit between the representation of position of contact between the learner's tongue and mouth during speech and the model

representation of position of contact between the model tongue and mouth during speech.

5        5. The method of claim 2 further comprising the step of  
providing positive reinforcement when the learner mimics the  
model representation of position of contact between the model  
tongue and mouth during speech.

10        6. The method of claim 5 wherein the positive  
reinforcement comprises computer generated congratulations.

15        7. The method of claim 5 wherein the positive  
reinforcement comprises dynamic displays on a computer  
monitor.

20        8. The method of claim 2 further comprising the step of  
automatically generating learning curve plots illustrating the  
ability of the learner to mimic the model.

25        9. The method of claim 1 wherein the representations of  
position of contact between the learner's tongue and mouth  
during speech and the model representations of position of  
contact between the model tongue and mouth during speech are

displayed on a split-screen.

10. The method of claim 2 further comprising the step of providing model acoustic representations of the speech.

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11. The method of claim 10 wherein auditory mimicry accuracy between the learner and the model acoustic representation are analyzed acoustically.

10 12. The method of claim 11 wherein a numerical score representing the closeness of acoustic fit is generated.

13. The method of claim 10 wherein sound spectrographic displays are generated from the model acoustic representation and the learner's speech.

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14. The method of claim 2 wherein the model representation is designed to exercise the learner's tongue when the learner mimics the model representation.

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15. The method of claim 2 wherein the model representation is designed to instruct the learner to compensate for physical deficiencies.

16. The method of claim 1 wherein the learner is unable to overcome speech disorders through traditional auditory based therapy.

5           17. The method of claim 1 wherein the learner has severe to profound hearing loss.

10           18. The method of claim 1 wherein the learner has stroke-limited ability to control tongue movement and placement.

19. The method of claim 1 wherein the learner has limited high frequency sound perception which causes lisping.

15           20. The method of claim 1 wherein the learner has reduced ability to build up pressure in the mouth.

20           21. The method of claim 1 wherein the learner has physical abnormalities affecting the mouth and vocal tract.

22. The method of claim 1 wherein the learner has limited energy to devote to speech activity.

23. The method of claim 1 wherein the learner is learning new speech patterns after cochlear implant surgery.

24. The method of claim 1 wherein the learner has  
5 gradually deteriorating hearing loss and needs assistance to maintain speech articulation skills.

25. The method of claim 1 wherein the learner is learning a speech pattern selected from the group consisting  
10 of a foreign language and a dialect.

26. The method of claim 1 further comprising:

(C) representing the position of contact between the learner's tongue and mouth during speech by a grid of dots on  
15 a computer screen, wherein said dots expand and change color responsive to contact between the learner's tongue and mouth.

27. The method of claim 26 further comprising:

(D) displaying a dental landmark on the computer screen  
20 to assist in orienting the position of contact between the learner's tongue and mouth.

28. The method of claim 26 wherein the grid of dots

corresponds to sensors disposed on a sensor plate which is custom fitted in the mouth of the learner.

29. The method of claim 1 wherein the speech includes  
5 sounds, words, phrases or sentences, and wherein the sounds, words, phrases, or sentences are displayed in writing.

30. The method of claim 1 wherein the position of  
10 contact between the learner's tongue and mouth during speech is recorded.

31. The method of claim 30 wherein the learner's speech  
is recorded acoustically corresponding to the position of  
contact between the learner's tongue and mouth during speech.

32. The method of claim 1 wherein the model  
15 representation is generated by a model speaker.

33. The method of claim 32 wherein the model speaker is  
20 representative of a particular age group, gender, or language type.

34. A method for assessing the proficiency of speech of

a speaker comprising:

(A) instructing the speaker to repeat a predetermined syllable set;

(B) measuring palatometric parameters of the speaker as  
5 the predetermined syllable set is repeated;

(C) comparing the palatometric parameters of the speaker with a standard;

35. The method of claim 34 wherein the predetermined  
10 syllable set includes a vowel, and wherein measuring the palatometric parameters includes measuring the time the learner requires to speak the vowel from vowel onset to offset.

15 36. The method of claim 34 wherein the predetermined syllable set includes a vowel, and wherein measuring the palatometric parameters includes measuring jaw separation at the vowel midpoint.

20 37. The method of claim 34 wherein measuring the palatometric parameters includes measuring the palatometric distance between an anterior most sensor contacted and a central incisor edge.

38. The method of claim 34 wherein measuring the palatometric parameters includes measuring the distance laterally between an innermost sensor contacted and a dental margin.

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39. The method of claim 34 wherein measuring the palatometric parameters includes measuring a surface area of the palate contacted by the tongue.

10 40. The method of claim 34 wherein measuring the palatometric parameters includes measuring a channel width at its narrowest point between sensors.

15 41. The method of claim 34 wherein measuring the palatometric parameters includes measuring the distance from a front sensor contacted to a central incisor tip sensor.

20 42. The method of claim 34 wherein measuring the palatometric parameters includes measuring a mid-sagittal distance between front and back sensor contacts during articulation of stop consonants.

43. The method of claim 34 wherein measuring the



palatometric parameters includes measuring a width of a stricture opening during articulation of fricatives, affricatives and laterals.

5           44.    The method of claim 34 wherein measuring the palatometric parameters includes measuring a time lapse from constriction release onset to a vowel steady-contact state.

10           45.    The method of claim 34 wherein measuring the palatometric parameters includes measuring a boundary of contact between the tongue and the palate.

15           46.    The method of claim 34 wherein measuring the palatometric parameters includes measuring the location of contact between the tongue and the palate.

20           47.    The method of claim 34 wherein the predetermined syllable set includes the phrase "have a CVC away;" wherein V is a vowel and C is a consonant.

          48.    The method of claim 34 wherein the predetermined syllable set includes the phrase "have a VCV away;" wherein V is a vowel and C is a consonant.

49. The method of claim 34 further comprising:

(D) representing the palatometric parameters by a grid of dots on a computer screen, wherein said dots expand and change color responsive to contact between the speaker's tongue and mouth.

50. The method of claim 49 further comprising:

(E) displaying a dental landmark on the computer screen to assist in orienting the contact between the learner's tongue and mouth.

51. The method of claim 49 wherein the grid of dots corresponds to sensors disposed on a sensor plate which is custom fitted in the mouth of the speaker.

52. A method for assessing speech for speech therapy comprising:

(A) instructing a user to contact a target with the user's tongue;

(B) utilizing a device having a plurality of sensors disposed in a series of perpendicular rows and columns to determine if the user contacts the target.

53. The method of claim 52 further comprising (c) measuring the time the user requires to touch the user's tongue on the target.

5 54. The method of claim 53 further comprising (D) comparing the time with a standard.

10 55. The method of claim 53 further comprising (D) comparing the time with a previous time measurement of the user.

15 56. The method of claim 52 wherein the target is located in the three-dimensional Euclidean space around the dental-gingival surface.

57. The method of claim 52 further comprising detecting the accuracy of the tongue placement.

20 58. The method of claim 53 wherein the time the user requires to contact the tongue on the target is started by a signal on a computer.

59. The method of claim 53 wherein the time the user

requires to contact the tongue on the target is started by a timer.

60. The method of claim 53 wherein the user is  
5 instructed to contact a plurality of targets in the user's mouth.

61. The method of claim 60 wherein the time the user  
requires to contact the tongue on the target is started by  
10 contacting another of the plurality of targets in the user's mouth.

62. The method of claim 53 wherein the velocity of the  
tongue is measured as the tongues moves from target to target.  
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63. The method of claim 52 further comprising:

(C) representing the plurality of sensors by a grid of  
dots on a computer screen, wherein said dots expand and change  
color responsive to contact between the user's tongue and the  
20 sensors.

64. The method of claim 63 further comprising:

(D) displaying a dental landmark on the computer screen

to assist in orienting the contact between the user's tongue and the sensors.

65. The method of claim 52 wherein the plurality of  
5 sensors are disposed on a sensor plate which is custom fitted in the mouth of the user.

66. The method of claim 52 wherein data is generated by  
contact with the user's tongue and the plurality of sensors;  
10 said data including the time and location of the contact.

67. The method of claim 66 wherein said data is stored for analysis and display.

68. The method of claim 52 wherein feedback is provided  
15 to the user to indicate the user's success in contacting the target.

69. A method for assessing speech for speech therapy  
20 comprising:

(A) instructing a user to contact the user's tongue on a target in the user's mouth;

(B) detecting the contact made by the user's tongue; and

(C) collecting measurements of the contact made by the user's tongue.

70. The method of claim 69 wherein the measurements  
5 include the time the user requires to make the contact with the user's tongue.

71. The method of claim 70 further comprising comparing the time with a standard.

10 72. The method of claim 70 further comprising comparing the time with a previous time measurement of the user.

73. The method of claim 69 wherein the target is located  
15 in the three-dimensional Euclidean space around the dental-gingival surface.

74. The method of claim 69 wherein the measurements  
include the accuracy of the contact with respect to the  
20 target.

75. The method of claim 70 wherein the time the user requires to contact the tongue is started by a signal on a

computer.

76. The method of claim 70 wherein the time the user requires to contact the tongue is started by a timer.

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77. The method of claim 70 wherein the user is instructed to contact a plurality of targets in the user's mouth.

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78. The method of claim 77 wherein the time the user requires to contact the tongue is started by contacting another of the plurality of targets in the user's mouth.

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79. The method of claim 69 wherein the measurements include the velocity of the tongue.

80. The method of claim 69 wherein the contact of the tongue is detected by a plurality of sensors.

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81. The method of claim 80 further comprising:

(D) representing the sensors by a grid of dots on a computer screen, wherein said dots expand and change color responsive to contact between the user's tongue and the

sensors.

82. The method of claim 81 further comprising:

(E) displaying a dental landmark on the computer screen  
5 to assist in orienting the contact between the user's tongue  
and the sensors.

83. The method of claim 80 wherein the plurality of  
sensors are disposed on a sensor plate which is custom fitted  
10 in the mouth of the user.

84. The method of claim 80 wherein data is generated by  
contact with the user's tongue and the plurality of sensors;  
said data includes the time and location of the contact.  
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85. The method of claim 84 wherein said data is stored  
for analysis and display.

86. The method of claim 69 wherein feedback is provided  
20 to the user to indicate the user's success in contacting the  
target.

87. A method for assessing speech for speech therapy



comprising:

(A) instructing a user to repeat a predetermined syllable set;

(B) detecting contact events between the user's tongue  
5 and mouth as the user repeats the predetermined syllable set;

(C) counting the contact events to determine a number of times the user repeats the predetermined syllable set in a given time.

10 88. The method of claim 87 further comprising (D) comparing the number of times the user repeats the predetermined syllable set in the given time with a standard.

15 89. The method of claim 87 wherein the predetermined syllable set comprises one of the group of syllables consisting of: pa, ta, ka, pata, taka, and pataka.

90. The method of claim 87 wherein the given time is five seconds.

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91. The method of claim 87 wherein the given time is started at a first contact event.

92. The method of claim 87 further comprising making secondary measures.

93. The method of claim 92 wherein said secondary  
5 measures include at least one of the group consisting of:  
response rate variability, rhythm disturbances, rate slowing,  
and drifting toward imprecise sound patterns.

94. The method of claim 87 wherein the number of times  
10 the user repeats the predetermined syllable set in a given  
time is displayed.

95. The method of claim 87 wherein the contact events  
between the user's tongue and mouth are detected by a  
15 plurality of sensors.

96. The method of claim 95 further comprising:

(D) representing the plurality of sensors by a grid of  
dots on a computer screen, wherein said dots expand and change  
20 color responsive to contact between the user's tongue and the  
sensors.

97. The method of claim 96 wherein further comprising:

(E) displaying a dental landmark on the computer screen to assist in orienting the contact events between the user's tongue and the sensors.

5           98. The method of claim 95 wherein the plurality of sensors are disposed on a sensor plate which is custom fitted in the mouth of the user.

10           99. A method for assessing speech for speech therapy comprising:

(A) instructing a user to speak an utterance which causes oral movements;

(B) electronically detecting the oral movements;

(C) detecting the acoustics of the user's voice.

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100. The method of claim 99 further comprising (D) comparing a time the oral movements occur with a time the user's voice begins to sound.

20           101. The method of claim 99 wherein the acoustics of the user's voice are detected by a microphone.

102. The method of claim 99 wherein the oral movements

are detected by a plurality of sensors.

103. The method of claim 102 further comprising:

5 (D) representing the plurality of sensors by a grid of dots on a computer screen, wherein said dots expand and change color responsive to contact between the user's tongue and the sensors.

104. The method of claim 103 further comprising:

10 (E) displaying a dental landmark on the computer screen to assist in orienting the contact between the user's tongue and the sensors.

15 105. The method of claim 102 wherein the plurality of sensors are disposed on a sensor plate which is custom fitted in the mouth of the user.

20 106. The method of claim 99 wherein the utterance includes the phrase "have a VCV away" where V is a vowel, and C is a consonant.

107. The method of claim 99 wherein detecting the oral movements includes detecting a stop consonant constriction

release moment.

108. The method of claim 99 wherein detecting the acoustics of the user's voice includes detecting a  
5 quasiperiodic vocal fold vibration onset denoting a vowel steady state.

109. The method of claim 99 further comprising determining the voice onset time.

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110. A method for providing speech therapy comprising:

(A) instructing a learner to perform a lingual movement;  
and

(B) displaying a representation of a position of contact  
15 between the learner's tongue and mouth during the lingual movement.

111. The method of claim 110 further comprising:

(C) representing the position of contact between the  
20 learner's tongue and mouth during the lingual movement by a grid of dots on a computer screen.

112. The method of claim 111 wherein said dots expand

and change color corresponding to contact between the learner's tongue and mouth.

113. The method of claim 111 further comprising:

5 (D) displaying a dental landmark on the computer screen to assist in orienting the contact between the learner's tongue and mouth.

10 114. The method of claim 111 wherein the grid of dots corresponds to sensors disposed on a sensor plate which is custom fitted in the mouth of the learner.

15 115. The method of claim 110 wherein the lingual movements are designed to exercise the tongue.

20 116. The method of claim 110 wherein the lingual movements are designed to develop compensatory tongue postures for the learner to overcome speech problems due to physical impairments.

117. A method of using a user's tongue to operate a device having electronic controls, said method comprising:

(A) establishing at least one contact point accessible to

the tongue;

(B) connecting said at least one contact point to the electronic controls of the device;

(C) contacting the at least one contact point with the  
5 tongue; and

(D) activating the device responsive to electrical flow to the tongue caused by contact between the user's tongue and the at least one contact point.

10 118. The method of claim 117 wherein the device is a wheelchair.

119. The method of claim 117 wherein the device is an electronic game.

15 120. The method of claim 117 wherein the device is a device which produces depictions of cartoon mouth movements.

121. The method of claim 117 wherein the at least one  
20 contact point comprises a plurality of contact points.

122. The method of claim 121 wherein the plurality of contact points each cause the electronic controls to perform

a different function.

123. The method of claim 117 wherein the at least one  
contact point is defined by a plurality of sensors; said  
5 sensors being disposed on a sensor plate in a grid  
arrangement.

124. The method of claim 123 wherein the sensor plate is  
custom fitted into the mouth of a user.

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125. A method for providing speech therapy comprising:

(A) displaying a model representation of a position of  
contact between a model tongue and mouth during speech;

(B) displaying a representation of a position of contact  
15 between a learner's tongue and mouth during speech;

(C) instructing the learner to mimic the model  
representation of the position of contact between the model  
tongue and mouth during speech;

(D) comparing the representation of the position of  
20 contact between the learner's tongue and mouth during speech  
with the model representation of position of contact between  
the model tongue and mouth during speech;

(E) generating a numerical score representing the



closeness of fit between the representation of position of contact between the learner's tongue and mouth during speech and the model representation of position of contact between the model tongue and mouth during speech;

5 (F) providing positive reinforcement when the learner mimics the model representation of position of contact between the model tongue and mouth during speech; and

(G) providing model acoustic representations of the speech;

10 wherein the representations of position of contact between the learner's tongue and mouth during speech and the model representations of position of contact between the model tongue and mouth during speech are displayed on a split-screen;

15 wherein auditory mimicry accuracy between the learner and the model acoustic representation are analyzed acoustically;

wherein a numerical score representing the closeness of acoustic fit is generated;

20 wherein sound spectrographic displays are generated from the model acoustic representation and the learner's speech;

wherein the position of contact between the learner's tongue and mouth during speech is represented by a grid of dots on said split-screen, said dots expand and change color

corresponding to contact between the learner's tongue and mouth;

wherein a dental landmark is displayed on the split-screen to help orient the position of contact between the learner's tongue and mouth;

wherein the grid of dots corresponds to sensors disposed on a sensor plate which is custom fitted in the mouth of the learner;

wherein the speech includes sounds, words, phrases or sentences, and wherein the sounds, words, phrases, or sentences are displayed in writing;

wherein the position of contact between the learner's tongue and mouth during speech is recorded; and

wherein the learner's speech is recorded acoustically corresponding to the position of contact between the learner's tongue and mouth during speech.

126. The method of claim 30 wherein the model representation is recorded.

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127. The method of claim 126 further comprising replaying the recorded position of contact between the learner's tongue and mouth during speech in synchronism with

the recorded model representation.

128. The method of claim 1 further comprising:

(C) displaying a model representation of a contact  
5 between a model lip and teeth during speech.

129. The method of claim 128 further comprising:

(D) displaying a representation of a contact between a  
learner's lip and teeth during speech.